

APPENDIX G-AQUA4 AQUATIC RESOURCES EFFECTS OF THE PROPOSED ACTION

This appendix provides qualitative analyses of potential effects on aquatic resources with implementation of the Proposed Action, relative to the No-Action Alternative. Although the following topical outline is consistent for analysis of both alternatives, effects on several issue areas are not anticipated to occur under the Proposed Action. From an aquatic resources perspective, there are only a few differences between the No-Action Alternative and the Proposed Action. (See Section 3.1, No-Action Alternative, and Section 3.2, Proposed Action, for a detailed description of the No-Action Alternative and Proposed Action conditions.) Flow releases from the Oroville Facilities, reservoir water surface elevations, and water temperatures with implementation of the Proposed Action are anticipated to be the same as under the No-Action Alternative. Therefore, no quantitative analysis is required or provided to show potential effects on aquatic resources related to changes in flows, reservoir water surface elevations, or water temperature and the resultant effects on the quantity, quality, or distribution of fish habitat.

Actions included in the Proposed Action that are relevant to the assessment of the effects on aquatic resources, and that are not included in the No-Action Alternative, consist of improving existing side-channel fish habitat, a Gravel Supplementation and Improvement Program, and a Large Woody Debris Supplementation and Improvement Program for the lower Feather River. Additionally, the Proposed Action includes fish barrier weirs for the segregation of spring-run Chinook salmon spawning, and adaptive management of the Feather River Fish Hatchery. The actions included in the Proposed Action are evaluated qualitatively in the subsections below. A detailed description of the methodology used to analyze potential effects on aquatic resources is provided in Appendix G-AQUA2, Methodology.

G-AQUA4.1 HABITAT COMPONENTS AFFECTED BY THE OROVILLE FACILITIES

G-AQUA4.1.1 Chinook Salmon Spawning Segregation

Two fish barrier weirs would be installed in the lower Feather River downstream of the Fish Barrier Dam and upstream of the Thermalito Afterbay Outlet with implementation of the Proposed Action. Installation of fish barrier weirs may provide for some level of segregation between spring- and fall-run Chinook salmon and may help alleviate some of the adverse effects of high spawning densities in this reach of the lower Feather River. Appropriately placed weirs could potentially simulate historic spatial segregation of runs by selectively allowing or blocking fish passage on a temporal basis.

In addition to providing a mechanism for segregation of spring- and fall-run Chinook salmon, weirs could reduce redd superimposition and its effects on salmonid productivity in the lower Feather River. (For a discussion of redd superimposition, particularly in the lower Feather River, see Study Plan [SP] F10, Task 2B, *Evaluation of Potential Effects of Facilities Operations on Spawning Chinook Salmon*, in Section G-

AQUA1.8.2 in Appendix G-AQUA1.) By controlling access to spawning habitat on a temporal basis, the adverse effects of redd superimposition, particularly on spring-run Chinook salmon, may be reduced.

Other potential benefits of installing weirs in the lower Feather River include providing a mechanism to allow collection of valuable data on timing, abundance, and movements of Feather River fish species. The installation of fish weirs would provide a flexible management tool for the reach of the Feather River between the Fish Barrier Dam and the Thermalito Afterbay Outlet.

Two fish weirs are proposed as part of the Proposed Action. The proposed location for the weir furthest upstream is near Bedrock Park at approximately River Mile (RM) 66. The proposed downstream location for the second weir is near Gateway Riffle at approximately RM 60. The installation of weirs in the lower Feather River may create some potential resource conflicts and necessitate some changes to project operations. For example, weirs could conflict with current fishing and boating recreation in this reach of the Feather River. (See Section 5.10.2.2 for additional information on the potential recreational effects of this action.) Additionally, placement of the upper weir at Bedrock Park would inhibit collection of fall-run Chinook salmon brood stock through the existing fish ladder located at the Fish Barrier Dam. The upstream fish barrier weir would include an egg taking station to replace fall-run Chinook salmon access to the Feather River Fish Hatchery fish ladder.

G-AQUA4.1.2 Macroinvertebrate Populations

Macroinvertebrate communities in the lower Feather River would likely benefit from implementation of the Proposed Action. The Large Woody Debris Supplementation and Improvement Program included in the Proposed Action would benefit macroinvertebrates by increasing habitat diversity and contributing nutrients. The Gravel Supplementation and Improvement Program would reduce substrate armoring, improving the quality of macroinvertebrate habitat. The side-channel improvement of Moe's Ditch and Hatchery Ditch would also offer increased and more diverse habitat for aquatic macroinvertebrates.

G-AQUA4.1.3 Woody Debris Recruitment

Implementation of the Proposed Action would include supplementing large woody debris in the lower Feather River to satisfy fish habitat improvement goals for the duration of the license period. The reach of the Feather River extending from the Fish Barrier Dam downstream to the Thermalito Afterbay Outlet is used intensively as spawning habitat for anadromous salmonids. The Large Woody Debris Supplementation and Improvement Program would contribute to both the geomorphic and ecological functions of the lower Feather River. Additional woody debris would enhance rearing habitat for juvenile salmonids by providing cover and would create scour pools that may serve as holding habitat for anadromous salmonids. Additional large woody debris would also trap sediment, allowing recruitment of riparian vegetation, and decaying large woody debris would provide an additional source of

instream nutrients for aquatic organisms. Large woody debris placed or recaptured in backwater mesohabitats below the Thermalito Afterbay Outlet may enhance habitat for warmwater species such as black bass.

The Proposed Action includes the placement of large woody debris in the lower Feather River primarily from the Fish Barrier Dam to the Thermalito Afterbay Outlet, and possibly in other locations downstream of the Afterbay Outlet. In general, single logs, groups of logs, or combinations of logs and boulders that are anchored or cabled together would be placed in the river (Flosi 1998). Anchoring would probably be required for projects that are intended to be site specific, such as riprapped banks or side channels. Wood may also be anchored at banks with cables or between natural or artificial structures.

Placement of large woody debris could create conflicts with landowners adjacent to the channel if bank erosion is inadvertently increased as a result of flow diversion. (See Section 5.8.2.2 for additional information on potential effects of a Large Woody Debris Supplementation and Improvement Program on land use.) Placement of large woody debris could also decrease river navigability in some areas. (See Section 5.10.2.2 for additional information on potential effects of a Large Woody Debris Supplementation and Improvement Program on recreation.)

Under current regulated-flow regimes, placements of large woody debris would provide localized benefits on fish habitat until a high flow event. When that occurs, the magnitude of the flow event would redistribute both naturally recruited and supplemented large woody debris. This redistribution is a normal ecosystem function; however, the large woody debris in the upstream reaches of the Low Flow Channel would need to be replaced following these events. In the event that large woody debris moves out of the Feather River during extreme flow events, it would provide fish habitat benefits downstream on the Sacramento River, perhaps as far as the Sacramento Delta.

G-AQUA4.1.4 Gravel Recruitment

The Proposed Action includes supplementing gravel in the lower Feather River directly below the Fish Barrier Dam and at selected anadromous salmonid spawning riffles between the Fish Barrier Dam and Honcut Creek that would benefit from spawning substrate improvement. The Proposed Action also provides for the ripping and raking of substrate in selected areas of the lower Feather River that are potential salmonid spawning sites, but where the substrate has become armored or sufficiently coarsened in particle size distribution to reduce salmonid spawning habitat quality. (See Section 5.3.1.1 for additional information on gravel conditions.)

Sites that may benefit from gravel supplementation were identified in SP-G2. Depending on the findings of surveys conducted after gravel supplementations, additional supplementations may be conducted in the same areas or certain sites may be abandoned. Likewise, potential sites that may benefit from ripping and raking were

identified in SP-G2. Future surveys may determine other areas where ripping and raking of substrate may enhance spawning habitat.

Information gathered from SP-G2 has identified specific sites downstream of the Fish Barrier Dam and upstream of the Thermalito Afterbay Outlet that may benefit from supplementation of spawning gravel. Supplementation of gravel at these locations is intended to increase suitable spawning habitat quality and quantity for anadromous salmonids by restoring habitat substrate. The spawning gravel supplement and improvement program would provide the greatest benefit to the spawning areas in the upstream-most portions of the Low Flow Channel below the Fish Barrier Dam because they currently have the most degraded substrate quality and the least suitability for salmonid spawning. Additionally, gravel supplemented near the base of the Fish Barrier Dam would be mobilized during high flow events and would be redistributed downstream, mimicking normal gravel recruitment that occurred before dam construction. Subsequent gravel placements would be required after future peak-flow events to maintain benefits provided by supplementation of spawning gravel. The improvement of spawning substrate in the upstream reaches of the Low Flow Channel complements the function of the fish barrier weirs—spatial segregation of spring-run Chinook salmon—by providing habitat enhancements in those locations that provide direct benefits to this ESA species.

G-AQUA4.1.5 Channel Complexity

Implementation of the Proposed Action includes enhancement of the existing side-channel habitat in Hatchery Ditch and Moe's Ditch, both located downstream of the Fish Barrier Dam and adjacent to the Feather River Fish Hatchery. Enhancements to these existing side channels could include reforming the channel for increased water depth and shoreline diversity, placing boulders and woody debris for cover and velocity diversity, and gravel substrate supplementation. The enhancement of these existing side channels would primarily benefit steelhead and spring-run Chinook salmon by increasing the quantity and quality of spawning and rearing habitat.

G-AQUA4.1.6 Water Quality Criteria for Aquatic Life

Water quality conditions for aquatic life are not expected to change with implementation of the Proposed Action, with the exception of any short-term water quality effects associated with instream construction activities such as the fish barrier weirs, enhancement of side-channel habitat, placement of large woody debris, or gravel placement, ripping, or raking. (See Section 5.4.2.2 for the evaluation of construction-related effects on water quality.)

G-AQUA4.2 WARMWATER RESERVOIR FISHERIES

G-AQUA4.2.1 Operations-related Effects

G-AQUA4.2.1.1 Spawning and Initial Rearing

No changes in reservoir water surface elevations, rates of reduction, or surface level fluctuations in Lake Oroville or Thermalito Afterbay are anticipated with implementation of the Proposed Action.

G-AQUA4.2.1.2 Fish Interactions

No changes in fish stocking or in the frequency of sediment wedge exposure from Lake Oroville water surface elevations are anticipated with implementation of the Proposed Action.

G-AQUA4.2.2 Fisheries Management–related Effects

G-AQUA4.2.2.1 Stocking

No changes in warmwater fish stocking or the habitat enhancement program are anticipated with implementation of the Proposed Action.

G-AQUA4.2.2.2 Disease

No changes in the types or rates of warmwater fish diseases are anticipated with implementation of the Proposed Action.

G-AQUA4.2.2.3 Recreational Access or Fishing Regulations

Recreation enhancements included in the Proposed Action are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access would be increased through the construction of a fishing pier or platform at the Diversion Pool and South Forebay DUA and increased shoreline access in the north Forebay through the construction of trails. (See Section 5.10.2 for additional information on recreation enhancements.) No changes in regulations for warmwater sport fishing are anticipated with implementation of the Proposed Action.

G-AQUA4.2.3 Summary of Potential Effects on Warmwater Reservoir Fisheries

Implementation of the Proposed Action would not affect the quality or quantity of warmwater fish habitat available in Oroville Facilities reservoirs.

G-AQUA4.3 COLDWATER RESERVOIR FISHERIES

G-AQUA4.3.1 Operations-related Effects

G-AQUA4.3.1.1 Habitat Availability

No changes in reservoir water surface elevations and the associated quality and quantity of effective available coldwater pool habitat in Lake Oroville are anticipated with implementation of the Proposed Action.

G-AQUA4.3.1.2 Fish Interactions

No changes in fish stocking or in the frequency of sediment wedge exposure from Lake Oroville water surface elevations are anticipated with implementation of the Proposed Action.

G-AQUA4.3.2 Fisheries Management-related Effects

G-AQUA4.3.2.1 Stocking

No changes in coldwater fish stocking are anticipated with implementation of the Proposed Action.

G-AQUA4.3.2.2 Disease

No changes in potential exposure to fish diseases is anticipated with implementation of the Proposed Action.

G-AQUA4.3.2.3 Recreational Access or Fishing Regulations

Recreation enhancements included in the Proposed Action are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access would be increased through the construction of a fishing pier or platform at the Diversion Pool and South Forebay DUA and increased shoreline access in the north Forebay through the construction of trails. (See Section 5.10.2 for additional information on recreation enhancements.) No changes in regulations for coldwater sport fishing are anticipated with implementation of the Proposed Action.

G-AQUA4.3.3 Summary of Potential Effects on Coldwater Reservoir Fisheries

Implementation of the Proposed Action would not affect the quality or quantity of coldwater fish habitat available in Oroville Facilities reservoirs.

G-AQUA4.4 LOWER FEATHER RIVER FISH SPECIES

The overall determination of effects on each species of primary management concern in the lower Feather River with implementation of the Proposed Action incorporates all of the types of effects associated with each PM&E measure included in the alternative for

each life stage of the species. Qualitative and quantitative analyses were performed on various potential effects resulting from implementation of the Proposed Action to determine the incremental effects associated with each PM&E measure included in the alternative. The results of the effects analysis of each PM&E measure on each life stage were synthesized to determine the overall effects of the alternative on the species.

G-AQUA4.4.1 Fall-run Chinook Salmon

G-AQUA4.4.1.1 Flow-related Effects

No flow changes are included in the Proposed Action; therefore, no flow-related effects on adult immigration, adult spawning and embryo incubation, or juvenile rearing and downstream movement by fall-run Chinook salmon are anticipated.

G-AQUA4.4.1.2 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on adult immigration, adult spawning and embryo incubation, or juvenile rearing and downstream movement by fall-run Chinook salmon are anticipated.

G-AQUA4.4.1.3 Predation-related Effects

No flow or water temperature changes are included in the Proposed Action; therefore, no changes are anticipated in the composition of predator species, or in distribution or consumption rates. Adaptive-management changes in steelhead hatchery release practices may reduce predation of juvenile salmonids.

G-AQUA4.4.1.4 Fisheries Management–related Effects

Hatchery

The Hatchery Adaptive Management Program included in the Proposed Action considers a range of potential changes in Feather River Fish Hatchery practices designed to reduce adverse effects of the hatchery on wild fish stocks and to improve the benefits to the Chinook salmon produced by the hatchery. Changes in hatchery practices intended to more successfully separate the breeding of spring-run vs. fall-run Chinook salmon would reduce the amount of genetic introgression between these two runs that may have previously occurred in the hatchery. Other potential adaptive management elements may include changes in steelhead size and timing of release to reduce potential steelhead predation on juvenile Chinook salmon. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to improve conditioning of rearing fish to wild behavior for predator avoidance and preference for cover. An enhanced fish marking program included in the adaptive management options would improve the ability to measure hatchery performance and increase the understanding of the fisheries resources in the lower Feather River.

Disease

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related interactions with the incidence of disease are anticipated.

Fishing Regulations, Poaching, and Change in Recreational Access and Visitation

Recreation enhancements included in the Proposed Action are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access in the lower Feather River is anticipated to increase with the implementation of the Proposed Action through the implementation of the fish barrier weirs and other recreation enhancements included in the Proposed Action. (See Section 5.10.2 for additional information on recreation enhancements.)

Installation of fish barrier weirs in the Lower Feather River would require no-fishing zones in the immediate proximity of the installations. Although the fish barrier weirs would be navigable by boats, the presence of the weirs may affect boating recreation activities to some degree. (See Section 5.10.2.2 for additional information about effects of fish barrier weirs on recreation.) Increased densities of fish below the fish barriers and river access on the weirs may potentially contribute to fish poaching opportunities with implementation of the Proposed Action.

G-AQUA4.4.1.5 Summary of Potential Effects on Fall-run Chinook Salmon

Study plan report summaries addressing project effects on fall-run Chinook salmon are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; Section G-AQUA1.5, Fisheries Management; Section G-AQUA1.8, Salmonids and Their Habitat in the Feather River Below the Fish Barrier Dam; and Section G-AQUA1.11, Predation, in Appendix G-AQUA1. A description of each life stage for fall-run Chinook salmon and the time period associated with it is presented in Appendix G-AQUA1, Affected Environment.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in immigration, spawning, or rearing habitat quantity and quality caused by water temperature or stage elevation changes. Additionally, there would be no changes in predation rates or disease incidence as a result of changes in water temperatures. Therefore, no water temperature or flow-related effects on any fall-run Chinook salmon life stage would occur with implementation of the Proposed Action.

Adult Immigration and Holding

Actions potentially affecting adult immigration and holding by fall-run Chinook salmon include a Hatchery Adaptive Management Program, fish barrier weirs, and a Large Woody Debris Supplementation and Improvement Program. The Hatchery Adaptive Management Program would potentially have a beneficial effect on immigrating adult

fall-run Chinook salmon by allowing more accurate identification of returning Feather River Fish Hatchery fish and by increasing genetic isolation between runs, thereby reducing effects on phenotypic separation with respect to immigration timing.

Installation of fish barrier weirs would have a beneficial effect on immigration by adult fall-run Chinook salmon by eliminating fishing pressure in the no-fishing zones in the vicinity of the fish barrier weirs. It would also increase genetic segregation of runs by spatially segregating holding adult spring-run Chinook salmon from immigrating fall-run Chinook salmon. However, the potential for increased poaching of fall-run Chinook salmon in the vicinity of the fish barrier weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those locations.

The Large Woody Debris Supplementation and Improvement Program would have a beneficial effect on immigrating adult fall-run Chinook salmon by creating potential velocity refuges.

Overall, implementation of the Proposed Action would result in a beneficial effect on fall-run Chinook salmon adult immigration and holding.

Spawning and Embryo Incubation

Actions potentially affecting adult spawning and embryo incubation by fall-run Chinook salmon include a Hatchery Adaptive Management Program, fish barrier weirs, and gravel supplementation. The hatchery adaptive management program would potentially have a beneficial effect by reducing genetic introgression between spring- and fall-run Chinook salmon.

Installation of fish barrier weirs in the lower Feather River likely would benefit adult spawning and embryo incubation by fall-run Chinook salmon by maintaining spatial segregation of spawning spring-run and fall-run Chinook salmon, and by eliminating fishing pressure on fish spawning in the no-fishing zones in the vicinity of the fish barrier weirs. However, the potential for poaching of fall-run Chinook salmon in the vicinity of the fish barrier weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those areas.

Gravel supplementation benefits fall-run Chinook salmon adult spawning and embryo incubation by increasing the amount of available spawning habitat, thereby reducing competition for available habitat and redd superimposition.

Overall, implementation of the Proposed Action would result in a beneficial effect on fall-run Chinook salmon adult spawning and embryo incubation.

Juvenile Rearing and Downstream Movement

Actions potentially affecting juvenile rearing and downstream movement by fall-run Chinook salmon include a Hatchery Adaptive Management Program, a Gravel Supplementation and Improvement Program, and a Large Woody Debris Supplementation and Improvement Program. The Hatchery Adaptive Management

Program would potentially have a beneficial effect on this life stage by improving genetic segregation between spring- and fall-run Chinook salmon. Additionally, by potentially altering the size and timing of juvenile steelhead released into the lower Feather River, the Hatchery Adaptive Management Program could reduce predation rates on rearing and emigrating fall-run Chinook salmon. By altering raceways at the Feather River Fish Hatchery, the Hatchery Adaptive Management Program could increase post-release survival rates of juvenile fall-run Chinook salmon.

The Gravel Supplementation and Improvement Program and Large Woody Debris Supplementation and Improvement Program would potentially have a beneficial effect on rearing and downstream migrating fall-run Chinook salmon by increasing channel complexity and the amount and quality of rearing habitat. However, placement of large woody debris could potentially have an adverse effect by increasing warmwater predator habitat downstream of the Thermalito Afterbay Outlet.

Overall, implementation of the Proposed Action would result in a beneficial effect on fall-run Chinook salmon juvenile rearing and downstream movement.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Action would result in an overall beneficial effect on fall-run Chinook salmon.

G-AQUA4.4.2 Spring-run Chinook Salmon

G-AQUA4.4.2.1 Flow-related Effects

No flow changes are included in the Proposed Action; therefore, no flow-related effects on adult immigration and holding, adult spawning and embryo incubation, or juvenile rearing and downstream movement of spring-run Chinook salmon are anticipated.

G-AQUA4.4.2.2 Water Temperature-related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature-related effects on adult immigration and holding, adult spawning and embryo incubation, or juvenile rearing and downstream movement of spring-run Chinook salmon are anticipated.

G-AQUA4.4.2.3 Predation-related Effects

No flow or water temperature changes are included in the Proposed Action; therefore, no changes are anticipated in the composition of predator species, or in distribution or consumption rates. Adaptive management changes in steelhead hatchery release practices may reduce predation of juvenile salmonids with implementation of the Proposed Action.

G-AQUA4.4.2.4 Fisheries Management–related Effects

Hatchery

The Hatchery Adaptive Management Program included in the Proposed Action considers a range of potential changes in hatchery practices designed to reduce adverse effects of the Feather River Fish Hatchery on wild fish stocks and improve the benefits to the Chinook salmon produced by the hatchery. Changes in hatchery practices intended to more successfully separate the breeding of spring-run vs. fall-run Chinook salmon would reduce the amount of genetic introgression between these two runs that may have previously occurred in the hatchery. Other potential adaptive management elements may include changes in steelhead size and timing of release to reduce potential steelhead predation on juvenile Chinook salmon. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to improve conditioning of rearing fish to wild behavior for predator avoidance and preference for cover. An enhanced fish marking program included in the adaptive management options would improve the ability to measure hatchery performance and increase the understanding of the fisheries resources in the lower Feather River.

Disease

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related interactions with the incidence of disease are anticipated.

Fishing Regulations, Poaching, and Change in Recreational Access and Visitation

Recreation enhancements included in the Proposed Action are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access in the lower Feather River is anticipated to increase with the implementation of the Proposed Action through the installation of fish barrier weirs and other recreation enhancements included in the Proposed Action. (See Section 5.10.2 for additional information on recreation enhancements.)

Installation of fish barrier weirs in the Lower Feather River would require no-fishing zones in the immediate proximity of the installations. Although the fish barrier weirs would be navigable by boats, the presence of the weirs may affect boating recreation activities to some degree. (See Section 5.10.2.2 for additional information on fish barrier weir effects on recreation.) Increased densities of fish below the fish barriers and river access on the weirs may potentially contribute to fish poaching opportunities with implementation of the Proposed Action.

G-AQUA4.4.2.5 Summary of Potential Effects on Spring-run Chinook Salmon

Study plan report summaries addressing project effects on spring-run Chinook salmon are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; Section G-AQUA1.5, Fisheries Management; Section G-AQUA1.8, Salmonids and Their Habitat in the Feather River Below the Fish Barrier Dam; and Section G-AQUA1.11 Predation,

in Appendix G-AQUA1. A description of each spring-run Chinook salmon life stage and the time period associated with it is presented in Appendix G-AQUA1, Affected Environment.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in habitat quantity and quality for the immigration and holding, spawning and embryo incubation, or juvenile rearing and downstream movement life stages as a result of water temperature or stage elevation changes. Additionally, there would be no changes in predation rates or disease incidence as a result of changes in water temperatures. Therefore, no water temperature or flow-related effects on any spring-run Chinook salmon life stage would occur with implementation of the Proposed Action.

Adult Immigration and Holding

Actions potentially affecting adult immigration and holding by spring-run Chinook salmon include a Hatchery Adaptive Management Program, fish barrier weirs, and a Large Woody Debris Supplementation and Improvement Program. The Hatchery Adaptive Management Program potentially would provide a beneficial effect by allowing more accurate identification of returning hatchery fish and by increasing genetic isolation between runs, thereby improving phenotypic separation between runs with respect to immigration timing.

Installation of fish barrier weirs would have a beneficial effect on spring-run Chinook salmon adult immigration and holding by eliminating fishing pressure within the no-fishing zones in the vicinity of the fish barrier weirs, and by increasing genetic segregation between runs by spatially segregating holding adult spring-run Chinook salmon from immigrating fall-run Chinook salmon. However, the potential for poaching of spring-run Chinook salmon in the vicinity of the fish barrier weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those locations.

Large woody debris supplementation upstream of the fish barrier weirs would have a beneficial effect on this life stage by creating potential velocity refuges for holding adult spring-run Chinook salmon.

Overall, implementation of the Proposed Action would result in a beneficial effect on spring-run Chinook salmon adult immigration and holding.

Adult Spawning and Embryo Incubation

Actions potentially affecting adult spawning and embryo incubation by spring-run Chinook salmon include a Hatchery Adaptive Management Program, fish barrier weirs, side-channel habitat enhancement, and a Gravel Supplementation and Improvement Program. The Hatchery Adaptive Management Program would potentially provide a

beneficial effect by reducing the rate of genetic introgression between spring- and fall-run Chinook salmon.

Installation of fish barrier weirs in the lower Feather River likely would benefit adult spawning and embryo incubation by spring-run Chinook salmon by maintaining spatial segregation of spawning spring-run and fall-run Chinook salmon, and by eliminating fishing pressure on fish spawning in the no-fishing zones in the vicinity of the fish barrier weirs. Additionally, fish barrier weirs would provide a beneficial effect by reducing competition for spawning habitat, which would reduce redd superimposition, and thereby increase embryo survival. However, the potential for poaching of spring-run Chinook salmon in the vicinity of the fish barrier weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those areas.

Side-channel habitat enhancement and the Gravel Supplementation and Improvement Program could potentially benefit spring-run Chinook salmon adult spawning and embryo incubation by increasing the amount of available spawning habitat, thereby reducing competition for available habitat and reducing redd superimposition.

Overall, implementation of the Proposed Action would result in a beneficial effect on spring-run Chinook salmon adult spawning and embryo incubation.

Juvenile Rearing and Downstream Movement

Actions potentially affecting juvenile rearing and downstream movement by spring-run Chinook salmon include a Hatchery Adaptive Management Program, side-channel habitat enhancement, a Gravel Supplementation and Improvement Program, and a Large Woody Debris Supplementation and Improvement Program. The Hatchery Adaptive Management Program would potentially have a beneficial effect on this life stage by increasing genetic segregation between spring- and fall-run Chinook salmon. Additionally, by potentially altering the size and timing of juvenile steelhead released into the lower Feather River, the Hatchery Adaptive Management Program could reduce predation on rearing and emigrating spring-run Chinook salmon. By altering raceways at the Feather River Fish Hatchery, the Hatchery Adaptive Management Program could increase post-release survival rates of juvenile spring-run Chinook salmon.

Side-channel habitat enhancement, the Gravel Supplementation and Enhancement Program, and the Large Woody Debris Supplementation and Improvement Program would potentially have a beneficial effect on rearing and downstream migrating spring-run Chinook salmon by increasing channel complexity and increasing the amount and quality of rearing habitat. However, placement of large woody debris could potentially have an adverse effect by increasing warmwater predator habitat downstream of the Thermalito Afterbay Outlet.

Overall, implementation of the Proposed Action would result in a beneficial effect on spring-run Chinook salmon juvenile rearing and downstream movement.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Action would result in an overall beneficial effect on spring-run Chinook salmon.

G-AQUA4.4.3 Steelhead

G-AQUA4.4.3.1 Flow-related Effects

No flow changes are included in the Proposed Action; therefore, no flow-related effects on adult immigration and holding, adult spawning and embryo incubation, fry and fingerling rearing and downstream movement, or smolt emigration by steelhead are anticipated.

G-AQUA4.4.3.2 Water Temperature-related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature-related effects on adult immigration and holding, adult spawning and embryo incubation, fry and fingerling rearing and downstream movement, or smolt emigration by steelhead are anticipated.

G-AQUA4.4.3.3 Predation-related Effects

No flow or water temperature changes are included in the Proposed Action; therefore, no changes are anticipated in the composition of predator species, or in distribution or consumption rates. Adaptive management changes in steelhead hatchery release practices may reduce predation of wild juvenile steelhead with implementation of the Proposed Action.

G-AQUA4.4.3.4 Fisheries Management-related Effects

Hatchery

A Hatchery Adaptive Management Program included in the Proposed Action considers a range of potential changes in hatchery practices designed to reduce adverse effects of the Feather River Fish Hatchery on wild fish stocks and improve the benefits to steelhead produced by the hatchery. These potential changes include changes in steelhead size and timing of release to reduce potential size advantages of hatchery steelhead over wild steelhead, as well as to reduce potential steelhead predation on wild juvenile steelhead. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to improve rearing fish conditioning to wild behavior for predator avoidance and preference for cover. An enhanced fish marking program included in the adaptive management options would improve the ability to measure hatchery performance and increase the understanding of the fisheries resources in the lower Feather River.

Disease

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related interactions with the incidence of disease are anticipated.

Fishing Regulations, Poaching, and Change in Recreational Access and Visitation

Recreation enhancements included in the Proposed Action are anticipated to increase recreation and angling. Increased angling is expected to result in increased sport fish harvest. Fishing access in the lower Feather River is anticipated to increase with the implementation of the Proposed Action through the installation of fish barrier weirs and other recreation enhancements included in the Proposed Action. (See Section 5.10.2 for additional information on recreation enhancements.)

Installation of fish barrier weirs in the lower Feather River would require no-fishing zones in the immediate proximity of the installations. Although the fish barrier weirs would be navigable by boats, the presence of the weirs may affect boating recreation activities to some degree. (See Section 5.10.2.2 for additional information on fish barrier weir effects on recreation.) Increased densities of fish below the fish barriers and river access on the weirs may potentially contribute to fish poaching opportunities with implementation of the Proposed Action.

G-AQUA4.4.3.5 Summary of Potential Effects on Steelhead

Study plan report summaries addressing project effects on steelhead are presented in Section G-AQUA1.5, Fisheries Management; Section G-AQUA1.8, Salmonids and Their Habitat in the Feather River Below the Fish Barrier Dam; and Section G-AQUA1.11, Predation, in Appendix G-AQUA1. A description of each steelhead life stage and the time period associated with it is presented in Appendix G-AQUA1, Affected Environment.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in holding, spawning, or rearing habitat quantity and quality as a result of water temperature or stage elevation changes. Additionally, there would be no changes in predation rates or disease incidence as a result of changes in water temperatures. Therefore, no water temperature or flow-related effects on any steelhead life stage would occur with implementation of the Proposed Action.

Adult Immigration and Holding

Actions potentially affecting steelhead adult immigration and holding include a Hatchery Adaptive Management Program, fish barrier weirs, and a large Woody Debris Supplementation and Improvement Program.

Installation of fish barrier weirs would have a beneficial effect on steelhead adult immigration and holding by eliminating fishing pressure within the no-fishing zones in the vicinity of the fish barrier weirs. However, the potential for poaching of steelhead in

the vicinity of the fish barrier weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those locations.

Large woody debris supplementation upstream of the fish barrier weirs would have a beneficial effect on this life stage by creating potential velocity refuges and cover.

Overall, implementation of the Proposed Action would result in a beneficial effect on steelhead adult immigration and holding.

Adult Spawning and Embryo Incubation

Actions potentially affecting steelhead adult spawning and embryo incubation include a Hatchery Adaptive Management Program, fish barrier weirs, side-channel habitat enhancement, and a Gravel Supplementation and Improvement Program. Installation of fish barrier weirs in the lower Feather River likely would benefit spawning and embryo incubation by steelhead by eliminating fishing pressure on fish spawning in the no-fishing zones in the vicinity of the fish barrier weirs. However, the potential for increased poaching of steelhead in the vicinity of the fish barrier weirs likely would be increased because of higher fish densities and increased access to the lower Feather River in those areas.

Side-channel habitat enhancement and the Gravel Supplementation and Improvement Program could potentially benefit steelhead adult spawning and embryo incubation by increasing the amount and quality of available spawning habitat, thereby reducing competition for available habitat and reducing redd superimposition.

Overall, implementation of the Proposed Action would result in a beneficial effect on steelhead adult spawning and embryo incubation.

Fry and Fingerling Rearing and Downstream Movement

Actions potentially affecting steelhead fry and fingerling rearing and downstream movement include a Hatchery Adaptive Management Program, side-channel habitat enhancement, a Gravel Supplementation and Improvement Program, and a Large Woody Debris Supplementation and Improvement Program. The Hatchery Adaptive Management Program would potentially have a beneficial effect on this life stage by altering the size and timing of juvenile steelhead released into the lower Feather River, reducing predation on emigrating steelhead. Other adaptive management elements could include changes to raceways at the Feather River Fish Hatchery to improve conditioning of rearing fish to wild behavior for predator avoidance and preference for cover.

Side-channel habitat enhancement, gravel enhancement, and the Large Woody Debris Supplementation and Improvement Program would all have a beneficial effect on rearing and downstream migrating steelhead by increasing channel complexity and increasing the amount and quality of rearing habitat. However, placement of large

woody debris could potentially have an adverse effect by increasing warmwater predator habitat downstream of the Thermalito Afterbay Outlet.

Overall, implementation of the Proposed Action would result in a beneficial effect on steelhead fry and fingerling rearing and downstream movement.

Smolt Emigration

Actions potentially affecting steelhead smolt emigration include a Hatchery Adaptive Management Program and a Large Woody Debris Supplementation and Improvement Program. The Hatchery Adaptive Management Program would have a beneficial effect on this life stage by potentially altering the size and timing of juvenile steelhead released into the lower Feather River, which could reduce predation rates on emigrating steelhead smolts. Additionally, by altering raceways at the Feather River Fish Hatchery, the program could increase post-release survival rates of steelhead smolts.

The Large Woody Debris Supplementation and Improvement Program would potentially have an adverse effect on steelhead smolt emigration by increasing warmwater predator habitat downstream of the Thermalito Afterbay Outlet.

Overall, implementation of the Proposed Action would result in a neutral effect on steelhead smolt emigration.

Conclusion

Based on the above summary of potential effects, it is likely that the Proposed Action would result in an overall beneficial effect on steelhead.

G-AQUA4.4.4 American Shad

G-AQUA4.4.4.1 Flow-related Effects

No flow changes are included in the Proposed Action; therefore, no flow-related effects on adult immigration and spawning by American shad are anticipated.

G-AQUA4.4.4.2 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on adult immigration and spawning by American shad are anticipated.

G-AQUA4.4.4.3 Summary of Potential Effects on American Shad

Study plan report summaries addressing project effects on American shad are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in immigration or spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature or flow-related effects on American shad with implementation of the Proposed Action.

G-AQUA4.4.5 Black Bass

G-AQUA4.4.5.1 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on black bass spawning are anticipated.

G-AQUA4.4.5.2 Summary of Potential Effects on Black Bass

Study plan report summaries addressing project effects on black bass species are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam; Section G-AQUA1.5, Fisheries Management; and Section G-AQUA1.11, Predation, in Appendix G-AQUA1.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature or flow-related effects on black bass with implementation of the Proposed Action.

G-AQUA4.4.6 Delta Smelt

G-AQUA4.4.6.1 Habitat Components

Adult Spawning

Delta smelt spawn in the upper Delta upstream of the mixing zone and use a range of substrates for spawning including reeds and other submerged vegetation, sandy or hard substrates, and submerged wood. The Large Woody Debris Supplementation and Improvement Program for the lower Feather River included in the Proposed Action is expected to contribute some large woody debris to the Delta and provide some contributions to habitat diversity and spawning substrate availability, benefiting delta smelt.

G-AQUA4.4.6.2 Summary of Potential Effects on Delta Smelt

Study plan report summaries addressing project effects on delta smelt are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1.

The distribution range of delta smelt is outside of the direct and indirect effects area for flows and water temperatures associated with the Oroville Facilities, therefore no flow or water temperature effects on delta smelt are anticipated with implementation of the Proposed Action. Delta smelt would potentially benefit from the Large Woody Debris Supplementation and Improvement Program for the lower Feather River as a result of its large woody debris contributions to the Delta, resulting in potential improvements in habitat quality and diversity.

G-AQUA4.4.7 Green Sturgeon

G-AQUA4.4.7.1 Flow-related Effects

No flow changes are included in the Proposed Action; therefore, no flow-related effects on adult immigration by green sturgeon are anticipated.

G-AQUA4.4.7.2 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on adult immigration, adult spawning and embryo incubation, juvenile rearing, or juvenile emigration by green sturgeon are anticipated.

G-AQUA4.4.7.3 Summary of Potential Effects on Green Sturgeon

Study plan report summaries addressing project effects on green sturgeon are presented in Section G-AQUA1.3, Fish and Their Habitat within Lake Oroville, its Upstream Tributaries, the Thermalito Complex, and the Oroville Wildlife Area; and Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature or flow-related effects on green sturgeon with implementation of the Proposed Action.

G-AQUA4.4.8 Hardhead

G-AQUA4.4.8.1 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on hardhead spawning are anticipated.

G-AQUA4.4.8.2 Summary of Potential Effects on Hardhead

Study plan report summaries addressing project effects on hardhead are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, with implementation of the Proposed Action, there would be no changes in spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, no water temperature or flow-related effects on hardhead would occur with implementation of the Proposed Action.

G-AQUA4.4.9 River Lamprey

G-AQUA4.4.9.1 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on river lamprey spawning are anticipated.

G-AQUA4.4.9.2 Summary of Potential Effects on River Lamprey

Study plan report summaries addressing project effects on river lamprey are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature or flow-related effects on river lamprey with implementation of the Proposed Action. River lamprey would benefit from improved spawning substrate conditions resulting from the Gravel Supplementation and Improvement Program with implementation of the Proposed Action.

G-AQUA4.4.10 Sacramento Splittail

G-AQUA4.4.10.1 Flow-related Effects

No flow changes are included in the Proposed Action; therefore, no flow-related effects on Sacramento splittail spawning are anticipated.

G-AQUA4.4.10.2 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on Sacramento splittail spawning are anticipated.

G-AQUA4.4.10.3 Summary of Potential Effects on Sacramento Splittail

Study plan report summaries addressing project effects on Sacramento splittail are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, with implementation of the Proposed Action, there would be no changes in spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature or flow-related effects on Sacramento splittail with implementation of the Proposed Action.

G-AQUA4.4.11 Striped Bass

G-AQUA4.4.11.1 Flow-related Effects

No flow changes are included in the Proposed Action; therefore, no flow-related effects on adult spawning, embryo incubation, or initial rearing by striped bass are anticipated.

G-AQUA4.4.11.2 Water Temperature–related Effects

No water temperature changes are included in the Proposed Action; therefore, no water temperature–related effects on adult spawning, embryo incubation, or initial rearing by striped bass are anticipated.

G-AQUA4.4.11.3 Summary of Potential Effects on Striped Bass

Study plan report summaries addressing project effects on striped bass are presented in Section G-AQUA1.4, Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam, in Appendix G-AQUA1.

Implementation of the Proposed Action would not alter flows or water temperatures in the lower Feather River compared to the No-Action Alternative. Specifically, there would be no changes in spawning habitat quantity and quality as a result of water temperature or stage elevation changes. Therefore, there would be no water temperature or flow-related effects on striped bass with implementation of the Proposed Action.

G-AQUA4.5 REFERENCES

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